CSS-06-1100

CALIBRATION STANDARD REQUIREMENT

FOR A

AUTOMATED PRESSURE CALIBRATION SYSTEM

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PROCUREMENT PACKAGE

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February 1996

Encl (1)

CALIBRATION STANDARD REQUIREMENT FOR AN AUTOMATED PRESSURE CALIBRATION SYSTEM

1. SCOPE

1.1 Scope. This requirement defines the salient mechanical, electrical, and electronic characteristics for an Automated Pressure Calibration System. This equipment is intended to be used by Navy personnel in a shipboard machinery room environment to generate and control pressure for the purpose of calibrating pressure gauges, switches, transducers, transmitters and other pressure measuring devices within the required ranges. For the purposes of this requirement, the Automated Pressure Calibration System shall be referred to as the APCS.

1.2 APCS System. The APCS shall be a portable microprocessor-based system consisting of no more than four separate components. These components consist of a pressure controller unit (PCU), a high pressure generation unit (HPGU), a nitrogen supply assembly (NSA), and an accessory case (AC) containing the applicable adapters, hose assemblies, fluid separator devices, etc. as described in paragraph 3.8.

2. APPLICABLE DOCUMENTS

2.1 Controlling Specifications. MIL-T-28800, "Military Specification, Test Equipment for use with Electrical and Electronic Equipment, General specification for," and all documents referenced therein of the issues in effect on the date of this solicitation shall form a part of this requirement. In addition, the following specifications and standards form a part of this requirement:

SPECIFICATIONS

Federal

BB-N-411C	Nitrogen, Technical

Military

MIL-M-7298D	Manuals, Technical: Commercial Equipment.
MIL-F-18866H	Fittings, Hydraulic Tube, Flared 37 Degree and Flareless, Steel.
MIL-G-18997E	Gage, Pressure, Dial Indicating.
MIL-P-24212C	Pressure Transducer Equipment (Electrical).

STANDARDS

Military

MIL-STD-167-1	Mechanical Vibrations of Shipboard Equipment (Type I - Environmental and Type II Internally Excited).
MIL-STD-101B	Color Code for Pipelines and for Compressed Gas Cylinders.

2.1.2 Other Government Publications. The following other Government publications also apply to the extent required herein.

Department of Transportation (DOT)

3AL - Compressed Gas Cylinders, Seamless Aluminum

3. REQUIREMENTS

3.1 General. The APCS shall conform to the Type II, Class 3, Style D requirements as specified in MIL-T-28800 for Navy shipboard and shorebased use as modified below. The use of material restricted for Navy use shall be governed by MIL-T-28800.

3.1.1 Design and Construction. The APCS design and construction shall meet the requirements of MIL-T-28800 for Type II equipment.

3.1.1.1 Enclosure Handles. Three handles shall be provided on each enclosure. One handle shall be located on the enclosure cover. The remaining two handles shall be located on opposite sides of the longest dimension.

3.1.2 Power Requirements. The APCS shall operate from a source of 103.5V to 126.5V at 50 and 60 Hz ±5% single-phase input power as specified in MIL-T-28800.

3.1.2.1 Fuses or Circuit Breakers. Fuses or circuit breakers shall be provided. If circuit breakers are used, both sides of the power source shall be automatically disconnected from the equipment in the event of excessive current. If fuses are used, only the line side of the input power line, as defined by MIL-C-28777, shall be fused. Fuses or circuit breakers shall be readily accessible on the front panel.

3.1.2.2 Power Connection. The requirements for power source connections shall be in accordance with MIL-T-28800. A power cord with a 6-foot (1.8 m) minimum length shall be provided for the PCU and HPGU.

3.1.3 Dimensions and Weight. All APCS enclosures shall be capable of passing thru a circular hatch 23 inches (58.4 cm)in diameter. Maximum dimensions for the PCU, HPGU, and AC shall not exceed 18 inches (45.7 cm) in width, 14 inches (35.6 cm) in height, and 14 inches (35.6 cm) in depth. Maximum dimensions for the NSA shall not exceed 30 inches (76.2 cm) in height and a diameter of 8 inches (20.3 cm). The weight shall not exceed 35 pounds (15.9 kg) for the PCU, 45 pounds (20.5 kg) for the HPGU, 35 pounds (15.9 kg) for the AC, and 30 pounds (13.6 kg) for the NSA.

3.2 Environmental Requirements. The APCS shall meet the environmental requirements for a Type II, Class 3, Style D equipment with the deviations required below.

3.2.1 Transit Drop. The APCS shall meet the requirements specified in 3.7.5.2 of MIL-T-28800E.

3.2.2 Temperature and Humidity. The APCS shall meet the conditions below:

	Temperature (°C)	Relative Humidity (%)
Operating	10 to 30	95
	30 to 40	75
Non-operating	-40 to 70	Not Controlled

3.2.3 Electromagnetic Compatibility. The electromagnetic compatibility requirements of MIL-T-28800 are limited to the following areas: CE01, CE03, CS01, CS02, CS06, RE01, RE02 (14 kHz to 1 GHz), and RS03.

3.3 Reliability. Type II reliability requirements are as specified in MIL-T-28800.

3.3.1 Calibration Interval. The APCS shall have an 85% or greater probability of remaining within tolerances of all requirements at the end of a 12 month period.

3.4 Maintainability. The APCS shall meet the Type II maintainability requirements as specified in MIL-T-28800 except the lowest discrete component shall be defined as a replaceable assembly. Certification time shall not exceed 3 hours.

3.5 Performance Requirements. The APCS shall provide the minimum performance capabilities required below. Unless otherwise indicated, all requirements shall be met following a 30-minute warm-up period which may include exercising the unit.

3.5.1 Engineering Units. The APCS shall have the capability to generate, control, and display pressure in the following units; feet sea water, feet water, inches water, inches Hg, mm Hg, psi (gauge and absolute), KPa, Kg-cm^2.

3.5.2 Pressure Ratings. All internal pressure tubing and fittings shall be of stainless steel construction with a rated operating pressure of 10,000 psig, a proof pressure of 15,000 psig, and a minimum burst pressure of 40,000 psig.

3.5.3 Range. The APCS shall have the capability to test and calibrate pressure gauges, switches, transducers, transmitters and other pressure measuring devices in the range of 0 inches of vacuum to 25 inches Hg of vacuum (minimum) and 0 psig to 10,000 psig.

3.5.4 Accuracy. The APCS shall not exceed the following total uncertainty throughout its operating temperature and humidity range: ±0.1 percent of indicated value (IV) throughout the required operating range of 0 to 10,000 psig; ±0.1 percent IV or ±0.015 inches Hg, whichever is greater in the vacuum range of 0 to 25 inches Hg. The total uncertainty is defined as the sum of all systematic uncertainty and random uncertainty and includes all effects of ambient temperature, hysterisis, linearity, non-repeatability, etc.

3.5.5 Resolution. The APCS shall provide the following minimum resolution:

Range	Resolution
Below 100 psig	0.001 psig
100 - 1000 psig	0.01 psig
1000 - 10000 psig	0.1 psig

3.5.6 Settability. The APCS shall provide as a minimum the settability given below. Settability is defined as the ability to set the output pressure to an exact cardinal test point value within a required tolerance without overshooting.

Range	Settability
Below 100 psig	±0.005 psig
100 - 1000 psig	±0.05 psig
1000 - 10000 psig	±0.5 psig

3.6 Operating Requirements. The APCS shall provide the following minimum operating capabilities.

3.6.1 Quick-disconnect Fittings. Unless otherwise specified, all quick-disconnect assemblies shall be designed for high pressure applications. Chained captive dust caps (or plugs) shall also be supplied. The fittings shall be of stainless steel construction, with a rated operating pressure of 10,000 psig, a proof pressure of 15,000 psig, and a minimum burst pressure of 40,000 psig. Quick-disconnect fittings shall be designed such that they are positive-locking to prevent inadvertent uncoupling when in use.

3.6.2. Pressure Controller Unit (PCU). The PCU shall be automatic in nature containing the necessary operating system software to perform calibration routines, monitor safety controls and provide the proper interface drivers. The PCU shall contain all required electronic and pneumatic controls to measure and control the pressure supplied to the test instrument (TI) throughout the pressure range required in 3.5.3. The PCU shall be designed for minimal operator effort and must perform all necessary calculations and/or conversions automatically.

3.6.2.1 Front Panel Control Requirements. All modes and functions shall be operable using front panel controls. The locations and labeling of indicators, controls, and switches shall provide for maximum clarity and easily understood operation without reference to tables, charts, or flow diagrams. The front panel shall contain as a minimum the following features:

(a) 40-character Alphanumeric display - minimum of 5 digits and character height of 0.20 inches. Displays operating instructions which prompt the operator to make entries or perform specific functions, self-test results, test point pressures and limits, APCS pressure, pass/fail indications, etc.

(b) Abort control - aborts operation and vents system pressure when engaged.

(c) Dust cover panels - used to protect connectors, pressure ports, and switches not used during any normal operation of the PCU.

(d) Emergency vent - mechanically actuated control which vents the system pressure to atmosphere.

(e) Fuse or circuit breaker.

(f) IEEE-488 Interface connector - standard interface (IEEE STD 488-1975) used for both automating the calibration of the APCS and using the APCS to calibrate other programmable instrumentation.

(g) Input power connector.

(h) Keyboard - minimum of 16 keys including Step (ahead and back), Clear, Enter and Measure keys, numeric characters and decimal point.

(i) Power switch - on/off switch which provides visual indication when equipment is energized.

(j) Pressure control - variable rate control which can electrically increase or decrease the pressure at varying rates to provide course or fine pressure adjustments to the exact test point pressure within the settability requirements of 3.5.6.

(k) Printer - provides a printed record on electrostatic paper, of test results including the date, TI serial number, TI range, TI tolerance, APCS test reading, TI test reading, deviation (in test units and percent), and pass/fail indication.

(l) Remote connector - receptacle for connecting a hand-held remote control terminal.

(m) Supply pressure port - port equipped with a high pressure quick-disconnect fitting used to connect the PCU to either the nitrogen supply cylinder or the HPGU.

(n) Test pressure port - port equipped with a high pressure quick-disconnect fitting used to supply pressure or vacuum from the PCU to the TI. The test port quick-disconnect fitting shall be designed such that only the liquid trap can be attached to this port.

(o) Vacuum port - port equipped with a precision low pressure quick-disconnect fitting used to connect a vacuum pump when calibrating vacuum or compound gauges.

3.6.2.2 Capabilities. The PCU shall have the following minimum capabilities:

(a) Ability to detect faults at the sub-assembly level via a built-in self-test.

(b) Allow for manual operator control of pressure points with audio feedback of pressure increase/decrease.

(c) Allow operator to repeat the measurement sequence on each calibration point and provide a full pressure hold function at any test point.

(d) Allow operator to easily and safely abort a test without damage to the APCS or TI.

(e) Automatically calculate test point tolerance limits, pressure unit equivalents and head corrections.

(f) Automatically establish, control and hold pressure at preset test points. Test points for standard and non-standard gauge ranges shall be selectable by the operator.

(g) Display operator instructions including sequential test instructions.

(h) Display the pressure deviation between the TI and APCS in percentage and in pressure units.

(i) Make in-tolerance and out-of-tolerance decisions by comparing the TI pressure reading to the APCS pressure reading.

(j) Measure and display the pressure for each test point.

(k) Monitor system for unsafe conditions and activate venting sequences.

(l) Print the complete TI test results.

(m) Provide for temporary data storage in memory.

(n) Provide for storage of calibration compensation data in electronic memory for each installed pressure sensor. This data shall be capable of being reprogrammed or updated when necessary.

3.6.2.3 Pressure Ports (Supply, Test and Vacuum). The pressure port assemblies shall be of the quick-disconnect type located on the front panel and aligned in the vertical plane. Adequate clearance shall be allowed for easy installation and removal of pressure hoses and test fixtures. The ports shall be constructed to prevent leakage when used throughout the operating range of the APCS.

3.6.2.4 Remote Control Mode. The APCS shall have the capability to be controlled remotely through a hand-held terminal. The purpose of the terminal is to provide TI calibrations remotely once the front panel has been initialized. The terminal shall be lightweight (maximum of 3 pounds) and capable of being held and operated with one hand. The remote control shall contain as a minimum the following features:

(a) Connector cable - electrical connector used to connect the remote to the PCU having a minimum length of 10 ft and detachable at both ends.

(b) Display - LED with a minimum of 5 digits and character height of 0.20 inches.

(c) Keyboard - Measure, Step and Abort keys.

(d) Pass/Fail indicator.

(e) Pressure control - variable rate control which can electrically increase or decrease the PCU pressure at varying rates to provide course or fine pressure adjustments to the exact test point pressure within the settability requirements of 3.5.6.

3.6.3 High Pressure Generation Unit (HPGU). The HPGU shall contain all the necessary electronic, pneumatic and/or hydraulic controls to boost gaseous dry nitrogen from the nitrogen supply cylinder up to 10,000 psig with a volume of not less than 5 cubic inches. The HPGU shall be capable of delivering the required pressures to the PCU by accepting nitrogen bottle pressures of 500 to 2,200 psi (minimum) and consuming a negligible amount of nitrogen in the process. Any fluid level checks and fills shall be accessible through the front panel without removing the HPGU from its enclosure. HPGU components which require the use of fluids shall be adequately sealed in order to prevent leakage during shipment. The use of fluids in the HPGU will require absolute isolation to prevent contamination of either the PCU of the TI.

3.6.3.1 Front Panel Control Requirements. All modes and functions shall be operable using front panel controls. The locations and labeling of indicators, controls, and switches shall provide for maximum clarity, visibility and easily understood operation without reference to tables, charts, or flow diagrams. The front panel shall contain as a minimum the following features:

(a) Output pressure port - port equipped with a high pressure quick-disconnect fitting used to supply pressure from the HPGU to the PCU.

(b) Output pressure indicator - pressure gauge having a range of 0 to 10,000 psig and accuracy of ±3 percent or better and is used to provide a visual indication of the actual pressure at the output port.

(c) Fuse or circuit breaker.

(d) Input power connector.

(e) Power switch - on/off switch which provides visual indication when equipment is energized.

(f) Pressure control - control valve which can be manually adjusted to increase or decrease the pressure being supplied to the HPGU output port.

(g) Pressure selection switch - manually operated selection switch that can be set at increments of 1,000 psig to limit the output pressure.

(h) Supply pressure port - port equipped with a high pressure quick-disconnect fitting used to connect the HPGU to the nitrogen supply cylinder.

(i) Vent control - control valve which can be manually adjusted to vent pressure from the output line to atmosphere.

3.6.3.2 Pressure Ports (Output and Supply). The pressure port assemblies shall be of the quick-disconnect type located on the front panel and aligned in the vertical plane. Adequate clearance shall be allowed for easy installation and removal of pressure hoses.

3.6.3.3 Pressure Rate. The pressure control valves shall be capable of responding to electrical drive signals in order to boost a supply pressure of 2,000 psig up to 10,000 psig within 60 seconds when the PCU test port is plugged. With a supply pressure of 1,000 psig the HPGU shall be capable of generating 10,000 psig at the PCU test port within 180 seconds.

3.6.4 Nitrogen Supply Assembly (NSA). The NSA shall consist of a supply cylinder, a valve manifold assembly and a valve guard and is to be used as a portable source for gaseous, high-purity nitrogen as specified in BB-N-411C, type I, class 1, grade B.

3.6.4.1 Nitrogen Supply Cylinder. The nitrogen supply cylinder used shall be a seamless aluminum compressed gas cylinder manufactured in accordance with DOT 3AL. The cylinder shall have a minimum service pressure of 2,200 psi and a minimum capacity of 57 standard cubic feet. The cylinder shall be color coded as specified in MIL-STD-101B. The nitrogen supply cylinders shall be delivered with a residual nitrogen pressure of 20 to 25 psi.

3.6.4.2 Valve Manifold Assembly. The valve manifold assembly shall be mounted on the neck of the nitrogen supply cylinder. Assembly controls shall be accessible to the operator without modifying the supply cylinder. The assembly controls shall consist of the following features as a minimum:

(a) Bleed valve - valve used to vent the supply hose before disconnecting it from the manifold.

(b) Bottle pressure indicator - pressure gauge having a maximum diameter of 1 inch, a minimum range of 0 to 2500 psig and an accuracy of ±3 percent or better. The gauge is used to provide a visual indication of the

supply cylinder pressure. The pressure gauge dial shall be visible to the operator.

(c) Manifold outlet - port equipped with a quick-disconnect fitting and used for connecting the supply hose.

(d) Rupture disc - prevents over-pressurization

(e) Shutoff valve - valve used to shutoff the supply cylinder pressure.

3.6.4.3 Valve Guard. The valve guard shall be mounted around the neck of the supply cylinder to protect the valve assembly from damage and shall be designed such that it can be used as a grip to carry the nitrogen supply cylinder. A tie-down strap with a minimum length of 4 feet shall be installed on the valve guard. A spring loaded thumb latch shall be installed on the free end of the strap to allow use as a tie-down for the nitrogen cylinder.

3.6.5 Pressure Limiters. The APCS shall provide the capability to automatically limit the maximum pressure which can be output to 110 percent of the full-scale range of the TI being calibrated. The maximum TI pressure range shall be selectable by the operator. Pressure limiters and/or relief valves shall also be used to protect the APCS pressure sensors from over- pressurization.

3.6.6 Pressure Venting. The APCS shall automatically vent to atmosphere and terminate the test operation with operator visual and audible notice whenever the applied pressure is greater than or equal to 110 percent of the entered full scale range of the TI. The system shall also automatically vent when the pressure is increased at a rate greater than 15 percent per second of the incremental pressure change. Automatic venting shall be directed away from the operator and PCU controls.

3.6.6.1 Emergency Venting. The APCS shall contain an independent, manual method of venting the pressure in case automatic venting fails. The emergency venting control shall be prominently displayed on the PCU and shall be different in design and size than the abort control thereby allowing the operator to easily distinguish between the two.

3.6.7 Nitrogen Consumption. The APCS shall be capable of calibrating a large quantity of test gauges having various ranges without recharging the nitrogen supply cylinder. For example, a properly designed system should be capable of calibrating a minimum of 100 pressure gauges having a full scale range of 8000 psig with a fully charged supply cylinder and a minimum of 450 gauges having a range of 1000 psig.

3.6.8 Error Correction. The APCS shall provide the capability to accept and store corrections for all measurement deviations from nominal conditions. The calibration constants shall be protected in such a manner that to change them requires the operator to enable a switch (not a key switch). The switch shall be accessible from the front control panel but located such that it cannot be accidentally enabled. The APCS shall be capable of changing any calibration factor or other correction data stored in memory of the APCS without removal of any memory circuits or devices. The correction capability shall be operable from both the front panel control and over the IEEE-488 bus. When the APCS is normally operated during a 12 month period, it shall meet all the specified performance requirements without requiring the additional entry of any calibration factor or other correction data by the operator, including correction data entered by an instrument controller.

3.6.9 Self-Test. The self-test shall comprise of two selectable levels, an operational test to determine if the instrument is operationally ready, and a second level diagnostic test to diagnose and isolate faulty field replaceable modules. When the self-test function is initiated, an auto-sequenced internal operation test shall be performed. The diagnostic test shall be selectable only by deliberate operator command.

3.6.10 IEEE Interface. The APCS shall have an IEEE-488.1 interface connector with the following minimum capabilities: SH1, AH1, T6, L4, SR1, RL1, DT1. Serial poll capability shall also be provided.

3.6.11 Compatibility. The APCS shall be tested and certified for compatibility with the IEEE-488 bus and the John Fluke model 1722A/AP instrument controller.

3.6.11.1 Calibration Standard. The APCS shall be tested and certified to be pneumatically and IEEE-488 bus compatible with the NAVY's precision pressure standard, model 3689A by King Nutronics Corporation.

3.6.11.2 Instrument Calibration Procedures. The APCS shall be compatible with all NAVAIR 17-20(Series) Instrument Calibration Procedures in effect on the date of this solicitation which require an automated portable pressure standard having an accuracy of 0.1% IV or better for calibrating pressure gauges, transducers and switches.

3.6.11.3 Pressure Gauges and Transducers. The APCS shall be pneumatically and electrically compatible with pressure gauges, transducers and switches specified in MIL-G-18997E and MIL-P-24212C that are within the range of the APCS.

3.6.11.4 Test and Maintenance Panel(TMP). The TMP is a portable microprocessor-based unit which can generate and control the PCU. It is used for testing and troubleshooting the PCU over the internal microprocessor bus. The proposed APCS shall either be fully compatible with existing Navy TMP's or a TMP must be provided with each five APCS units as part of this solicitation. The TMP shall have the following minimum capabilities and/or features:

(a) Alphanumeric display.

(b) Display instructions, addresses, and executed data.

(c) Display and modify internal register data.

(d) Extender cable for input/output data to and from the APCS.

(e) Input power shall be derived from the APCS.

(f) Operation of the TMP shall not displace or overlay the APCS's resident operating system.

(g) Provide detailed fault analysis of the APCS microprocessor, common bus system, I/O interfaces, memory modules and all other APCS subsystems.

(h) Run/halt and single step operations including pause and restart functions.

(i) Stand alone operation - panel shall not require the use of external peripherals in order to operate, e.g., paper tape, card, mag tape readers, teletype, CRT terminal, etc.

3.6.11.5 Material Compatibility. All APCS components, including internal tubing and seals, that are in direct contact with the pressure media shall be compatible with nitrogen, air, fresh water, sea water, lube oil, hydraulic oil and any required cleaning solvents.

3.6.12 Calibration.

3.6.12.1 APCS Calibration. The APCS shall have the capability to be calibrated automatically or manually. A manual calibration routine is used when the APCS is calibrated with a Dead Weight Tester. The operator would be required to control pressure rates and enter in the necessary data on the PCU front control panel. Automatic calibrations shall be performed over the IEEE-488 bus using the NAVY's precision pressure standard, model 3689A by King Nutronics Corporation. The APCS shall contain the necessary drivers to control the model 3689A during the calibration. A

sufficient number of test points shall be taken to verify whether the APCS is operating within its accuracy requirement.

3.6.12.2 TI Calibration. The APCS shall have the capability to perform TI calibrations using manual or automatic test point entry for standard pressure ranges. Both up-scale and down-scale testing shall be selectable. A typical 10 point automatic test on a 10,000 psi gauge should require no more than 15 minutes to calibrate.

3.6.13 Contamination. The APCS shall have the capability of calibrating both pneumatic and liquid-filled TI's without contaminating the PCU or HPGU. A liquid trap and pressure media separator shall be used to isolate the liquid used in the TI from the gas used in the APCS. The performance capabilities of the liquid trap and pressure media separator are required in 3.8.3 and 3.8.6, respectively.

3.7 Manual. At least two copies of an operation and maintenance manual shall be provided. The manual shall meet the requirements of MIL-M-7298D.

3.7.1 Calibration Procedure. A calibration procedure in accordance with MIL-M-38793 shall be provided.

3.8 Accessories. The APCS accessories shall be located in an accessory case (AC). The AC enclosure shall be of the same design as the PCU and HPGU and shall contain, as a minimum, the accessories required in 3.8.1 through 3.8.1.2. Quick-disconnect assemblies shall be designed as required in 3.6.1.

3.8.1 Adapter Kit Assembly. The adapter kit shall consist of the following stainless steel adapters, each having a length not to exceed 4 inches (6 inches for tube adapters):

1/8-27 NPT female to male quick-disconnect

1/8-27 NPT male to male quick-disconnect

1/4-18 NPT female to male quick-disconnect

1/4-18 NPT male to male quick-disconnect

1/4 inch male superpressure to male quick-disconnect

1/4 male tube to male quick-disconnect

1/2-20 NPT female to male quick-disconnect

1/2-20 NPT male to male quick-disconnect

MIL-I-18997 pressure fitting to male quick-disconnect

Tubing - 90 degrees; 1/4 female AN swivel (Air Force/Navy Aeronautical Standard drawing) on each end

Tubing - straight; 1/4 female AN swivel on each end

Tubing - 90 degrees; 1/4 female AN swivel to MS (Military Standard drawing)

Tubing - straight; 1/4 female AN swivel to MS

Charging adapter; female AN816-4 to female quick disconnect; used to connect the supply cylinder to another nitrogen supply via the supply hose in order to recharge the cylinder.

3.8.1.1 Adapter Design. The adapters shall be of stainless steel construction, with a rated pressure of 10,000 psig, a proof pressure of 15,000 psig, and a minimum burst pressure of 40,000 psig. The adapters shall have hex flats to facilitate adapter installation and removal.

3.8.1.2 Adapter Packaging. The adapters shall be contained within a heavy-duty, durable reusable plastic box labeled "Adapter Kit".

3.8.2 Liquid Chargers. Two liquid chargers shall be provided. The liquid charges are used to fill the reservoir in the pressure media separator and the TI.

3.8.3 Liquid Trap. One liquid trap shall be provided. The liquid trap is used to ensure that no contaminates or liquids from the TI side of the test set-up enter into the PCU plumbing lines. The trap shall be designed such that it can be installed into the test pressure port on the PCU and can be easily cleaned or purged without disassembly. The trap shall have the following features and requirements as a minimum:

(a) Female quick-disconnect - fitting used to mate the liquid trap to the TI or pressure media separator.

(b) Male quick-disconnect - fitting used to mate the liquid trap to the PCU. This fitting shall be designed such that it must be connected to the PCU test port before installing any other device.

(c) The liquid trap shall have a minimum capacity of 1.0 cubic inches.

(d) The liquid trap shall have an operating pressure of 10,000 psig, a proof pressure of 15,000 psig and a minimum burst pressure of 40,000 psig.

3.8.4 Packing Repair Kit Assembly. The packing kit assembly shall contain at least one of all replaceable sub-assembly gaskets, rings, seals, seats, etc. which are required for a complete overhaul of the pneumatic system. The replacement parts should be grouped together for each subassembly and individually packaged and sealed air tight in a seal kit. They shall also be identified by part number corresponding to the spare parts list contained in the Operation and Maintenance manual. A seals kit for each fluid separator shall also be provided. The seals kit should contain a spare diaphragm, if required by the pressure media separator. Other required accessories include but are not limited too the following:

(a) 2 oz. supply of seal lubricant.

(b) Pressure media separator support chain; minimum of 3 ft length.

(c) Continuity tester complete with alligator clip.

(d) Spare fuses, if required.

(e) Special devices or tools, as required.

3.8.4.1 Packing Kit Packaging. The packing kit shall be contained within a heavy-duty, durable reusable plastic box labeled "Packing Kit".

3.8.5 Pressure Hose Assemblies. Minimum design and performance requirements for pressure hoses shall be as required in 3.8.5.1 through 3.8.5.3. The hose assemblies shall be designed such that they can be disassembled for inspection and repairs. Hose quick-disconnect fittings shall be designed such that they are positive-locking to prevent inadvertent uncoupling when in use. The minimum bend radius for all hoses shall be 2.5 inches.

3.8.5.1 High Pressure Hose Assemblies. Two 10 ft, flexible high pressure hose assemblies with quick-disconnect fittings shall be supplied for connecting the PCU test pressure output port to the TI. The high pressure hoses shall be of stainless steel construction, with a rated operating pressure of 10,000 psig, a proof pressure of 15,000 psig, and a minimum burst pressure of 40,000 psig.

3.8.5.2 HPGU to PCU Connector Hose Assembly. One 5 ft, flexible high pressure hose assembly with quick-disconnect fittings shall be supplied for connecting the HPGU discharge pressure output port to the PCU supply pressure port. The high pressure hose shall be of stainless steel construction, with a rated operating pressure of 10,000 psig, a proof pressure of 15,000 psig, and a minimum burst pressure of 40,000 psig.

3.8.5.3 Supply Pressure Hose Assembly. One 5 ft, flexible supply pressure hose assembly with quick-disconnect fittings shall be supplied for connecting the nitrogen supply cylinder to the HPGU. The fittings shall be designed such that the hose cannot be connected to the pressure outlet ports on the HPGU and PCU. The supply pressure hose shall be of stainless steel construction, with a rated operating pressure of 3,000 psig, a proof pressure of 4,500 psig, and a minimum burst pressure of 12,000 psig.

3.8.6 Pressure Media Separators. Two separators shall be provided. The separator is used to isolate the liquid pressure media (water or oil) used in the TI from the gas pressure media (nitrogen) used in the PCU. The separator shall be clearly identified for the type of media to be used and shall be designed such that it can be mounted on a wall or bench or installed into a liquid trap. All separator components shall be compatible with nitrogen, fresh water, sea water, lube oil, hydraulic oil and any required cleaning solvents. As a minimum, the separator shall have the following features and requirements:

(a) Fill plug - plug used to allow easy filling of separator.

(b) Female quick-disconnect - fitting used to mate the liquid side of the separator to the TI.

(c) Male quick-disconnect - fitting used to mate the gas side of the separator to a high pressure hose or liquid trap.

(d) The separator shall have a minimum capacity of 2.5 cubic inches on the fluid side.

(e) The separator shall have an operating pressure of 10,000 psig, a proof pressure of 15,000 psig and a minimum burst pressure of 40,000 psig.

(f) The separator shall have a maximum pressure loss of 0.01 psig.

(g) The separator shall be constructed in a manner that ensures 100% separation of the liquid/nitrogen mediums.

3.8.7 Storage Bottles. Two plastic storage bottles having a minimum capacity of 1 quart shall be provided for storing the fluids and/or solvents used with the pressure media separators.

4.0 QUALITY ASSURANCE PROVISIONS

4.1 General. The APCS shall be tested in accordance with the bid sample tests specified in MIL-T-28800 for Type II, Class 3, Style D equipment. The bid sample tests shall include those tests specified in MIL-T-28000 except where modified below as well as the tests required in the following paragraphs.

4.1.1 Operation Test. The operation test shall consist of a pressure vent test and an accuracy test as required in 4.2.3.1 and 4.3.1.6, respectively.

4.2 Group A Tests. Group A tests shall include the tests specified in MIL-T-28800 as modified below.

4.2.1 Preoperational Inspection. The preoperational inspection shall be in accordance with MIL-T-28800 and shall include a verification of the condition and acceptability of the accessories required in 3.8.

4.2.2 Proof Pressure. Pressure hose assemblies and test instrument adapters shall be subjected to a proof pressure test equal to 150% of maximum operating pressure for a period of 1 hour, minimum. There shall be no sign of visual defects or leakage throughout the rest of the bid samples tests.

4.2.3 Level A Performance.

4.2.3.1 Pressure Venting. The APCS shall be subjected to the pressure vent tests as required in 4.2.3.1.1 through 4.2.3.1.3.

4.2.3.1.1 Overpressure. Connect a pressure gauge to the test port on the PCU. Select the full scale TI pressure range on the PCU. Set the APCS at the selected full scale pressure. Increase the pressure until the APCS vents. Verify that the system vents at a pressure no greater than 110% of the full scale range selected. Perform the same test at 3 more pressure test points.

4.2.3.1.2 Excessive Rate. Connect a pressure gauge to the test port on the PCU. Begin increasing the pressure such that the rate of rise is greater than 15 percent/second of the incremental change. For example, if the test point is 100 psi increase the pressure at a rate greater than 15 psi/second. Verify that the system vents. Perform the same test at 3 more pressure points throughout the range of the APCS.

4.2.3.1.3 Emergency Vent. Connect a pressure gauge to the test port on the PCU. Select a pressure test point and increase the pressure. As the pressure passes through the pressure point selected, enable the manual emergency vent control. Verify that the system vents immediately. Perform the same test at 3 more pressure points throughout the range of the APCS.

4.2.3.2 Abort. Connect a pressure gauge to the test port on the PCU. Select a pressure test point and increase the pressure. Before the pressure reaches the first test point, depress the abort control. Verify that the system immediately vents to zero and the test sequence returns to the first step. Perform the same test at 3 more pressure points throughout the range of the APCS.

4.3 Group B Tests. Group B tests shall include the tests specified in MIL-T-28800 as modified below.

4.3.1 Level B Performance. The bid samples shall be tested for conformance to the performance requirements required in 3.5. The tests shall include those required in 4.3.1.1 through 4.3.1.6 below.

4.3.1.1 Pressure Range. Verify that the APCS can generate, measure, and display pressure over the minimum pressure ranges required in 3.5.3.

4.3.1.2 Engineering Units. Generate a pressure of 50 psig at the test port of the PCU. Verify that the APCS can display the pressure in the correct units for feet sea water, feet water, inches water, inches Hg, mm Hg, psi (gauge and absolute), and KPa. Perform the same test at pressures of 500, 5000, and 10000 psig. Connect a vacuum pump to the PCU vacuum port and generate a vacuum pressure of 15 in Hg absolute. Verify that the APCS displays the correct conversion factors. To verify psia equivalents measure the barometric pressure with a calibrated standard having an accuracy of ±0.003 in Hg or better. The conversion factors used for this test are as follows:

1 psi	=	2.245677 ft sea water
		2.3108010 ft water
		27.729612 in water
		2.0360235 in Hg
		51.714928 mm Hg
		0.0703069 kg/cm^2
		6.8947567 KPa

4.3.1.3 Pressure Head Correction. Generate a pressure of 10 psig at the test port of the PCU. Simulate positive and negative head pressures of 10 inches and 60 inches using the following fluids: lube oil, hydraulic oil, fresh water, sea water. Verify that the APCS correctly calculates the head correction and displays the corrected pressure at the PCU test port. The conversion factors used for this test are as follows:

1 inch sea water	=	0.0371083 psi
1 inch fresh water	=	0.0360625 psi
1 inch lube oil	=	0.0315368 psi
1 inch hydraulic oil	=	0.0313023 psi

4.3.1.4 Resolution. Verify that the APCS can generate, measure, and display pressure within the minimum resolution required in 3.5.5. Select 3 test points throughout each pressure range required in 3.5.3 and/or each pressure sensor range. Plug the PCU test port before performing this test.

4.3.1.5 Settability. Verify that the APCS can generate, measure, and display pressure within the minimum settability required in 3.5.6. Select 3 test points throughout each pressure range required in 3.5.3 and/or each pressure sensor range. Plug the PCU test port before performing this test.

4.3.1.6 Accuracy. Connect a high accuracy pressure standard having a minimum accuracy of 0.025% IV to the PCU test port. Generate several pressure points (minimum of 10 points per range and/or pressure sensor) throughout the ranges required in 3.5.3 on the APCS and verify that the pressure readings are within the accuracy required in 3.5.4. Measurements are to be made upscale and downscale.

4.3.2 Automatic Hold. Verify that the APCS provides the capability to automatically hold test point pressures.

4.3.3 Automatic Test Point Selection. Verify that the APCS provides the capability to provide automatic test points.

4.3.4 Pressure Rate. Verify that the APCS meets the pressure rate requirements required in 3.6.3.3.

4.3.5 Nitrogen Consumption. Verify that the APCS meets the nitrogen consumption requirements required in 3.6.7.

4.3.6 Error Correction. Verify that the APCS meets the error correction requirements required in 3.6.8.

4.3.7 Self-Test. Verify that the APCS meets the self-test requirements required in 3.6.9.

4.3.8 Compatibility. Verify that the APCS meets the compatibility requirements required in 3.6.11.

4.3.9 Calibration. Verify that the APCS meets the calibration requirements required in 3.6.12.

4.3.10 Contamination. Verify that the APCS meets the contamination requirements required in 3.6.13.

4.4 Group C Tests. Group C tests shall include the tests specified in MIL-T-28800 as modified in 4.4.1 through 4.4.5 below.

4.4.1 Temperature and Humidity (T/H). Perform a T/H test in accordance with MIL-T-28800 for Class 3 equipment as modified by the operating and non-operating conditions required in 3.2.2 of this requirement. Verify that the APCS meets the performance requirements of the T/H testing.

4.4.2 Transit Drop. Perform a transit drop test in accordance with MIL-T-28800 for Type II, Style C equipment using a drop height of 6 inches. Verify that the APCS meets the performance requirements of the operation test after being subjected to the transit drops.

4.4.3 Water Resistance. Perform a drip-proof test in accordance with MIL-T-28800 for Type II, Style C equipment. Verify that the APCS meets the performance requirements of the operation test after being subjected to the drip-proof test.

4.4.4 Electrical Power. Perform the electrical power tests in accordance with MIL-T-28800 for Type III equipment. Verify that the APCS meets the performance requirements required.

4.4.5 Group C Verification. Perform the Group C verification tests in accordance with MIL-T-28800. Group C verification tests shall include Level A and Level B performance tests required in 4.2.3 and 4.3.1, respectively.

4.5 Group D Tests. Group D tests shall include the tests specified in MIL-T-28800 as modified below.

4.5.1 EMI. Perform EMI tests in accordance with MIL-T-28800 for Type III, Class 3 equipment as modified by the compatibility requirements of 3.2.3.

4.5.2 Group D Verification. Perform the Group D verification tests in accordance with MIL-T-28800. Group D verification tests shall include Level A and Level B performance tests required in 4.2.3 and 4.3.1, respectively.

4.6 Group E Tests. Group E tests shall include the tests specified in MIL-T-28800 as modified below.

4.6.1 Maintainability. Documentation shall be submitted with the bid samples to show how the maintainability characteristics of the APCS comply with MIL-T-28800. Verify that the APCS conforms to the maintainability requirements of MIL-T-28800.

4.6.2 Marking and Identification. Verify that the APCS and all component parts conform to the marking and identification requirements of MIL-T-28800.

4.7. Group F Tests. Group F tests shall include the tests specified in MIL-T-28800 as modified below.

4.7.1 Reliability. Documentation shall be submitted with the bid samples to show how the reliability characteristics of the APCS comply with MIL-T-28800. Verify that the APCS conforms to the reliability requirements of MIL-T-28800.